2004 SURF Summer Seminars and Tours

May 24 First official workday and Orientation for Session I students

May 28 "How's It Going" Rap Session

This was a general session for students to discuss their expectations and those of their advisors and to air any concerns or feedback about things to date.

June 1 NIST Virtual Library (NVL) Demos and NIST Research Library Tour

The sessions provided an overview and tour that includes demonstrations of the Library facilities, both manual and computer-based. This tour/demo was also repeated for the second session students.

June 4 Robert Ivester
NIST Manufacturing Engineering Laboratory, Manufacturing Metrology Division

Simultaneous Visual and Infrared Microscopy of Machining Processes

Using a separate camera and a beam splitter, researchers in MEL are able to obtain simultaneous visual and infrared images of the metal cutting processes. The beam splitter makes it possible to simultaneously image the machining process in both the thermal spectrum and the visual spectrum. With this technique they can estimate the emissivity of metal chips resulting from orthogonal cutting processes. The talk will highlight the machining experiments of metal chips from a variety of known cutting conditions. The emissivity of the workpiece material is a function of the cutting conditions and cutting temperatures. Prior emissivity estimates were based on spectral reflectance measurements of large (20-mm diameter) material samples with very low surface roughness and negligible plastic strain. While these samples correspond very closely to the initial state of the surface of the workpiece, they are dramaticaly different from the surface of the formed chip. Spectral reflectance measurements require a much larger surface than is possible to produce in a machined chip and it is not possible to use that approach to measure the emissivity of the chip (typically 0.5 mm wide). The difference between the emissivity of the initial workpiece and the final chip is particularly large for aluminum, where the emissivity changes from 0.045 to 0.19 as a result of the machining process. Since high-speed recordings of infrared emissions are used to measure the micro-scale temperature distribution in

the workpiece, cutting tool and chip, it is essential to know the emissivity of the chip to obtain reasonable measurement uncertainty while machining aluminum. Infrared emissions are directly proportional to emissivity, so when the camera recordings are converted to temperature, inaccuracy in the emissivity directly transfers to inaccuracy in the resulting temperatures. It is anticipated that this technique will enable an order of magnitude reduction in measurement uncertainty for the chip temperatures during machining.

June 9 NIST Safety Orientation for Summer Students

The session provided an overview, including how to report emergencies, use of personal protective equipment, general safety, office ergonomics, lab safety, and radiation safety.

June 14 First official workday and Orientation for Session II students

June 18 Edwin R. Fuller, Jr.
NIST Materals Science and Engineering Laboratory, Ceramics Division

Microstructural Stresses: Networks, Structural Reliability, and Antiquity Preservation

Macroscopic behavior and ensemble physical properties of heterogeneous materials, such as polycrystalline ceramics or stone, depend on the thermoelastic properties of the constituent phases, their morphology, and their topology. Or simply, on the crystallites, their shape, and how they are arranged. Because crystalline properties (crystallographic texture) as well as distributional aspects of crystallite shape and spatial arrangements. A property profoundly affected by these heterogeneous and stochastic features is the internal, or microstructural stresses. Their influence on behavior can be either deleterious, as in performance degradation of ceramic components or physical deterioration of stone sculptures and monuments, or advantageous, as in transformation and grain-bridging tuoghening phenomena. Microstructural stresses occur from many causes: temperature changes in conjunction with thermal expansion differences between features, phase transformations, or crystallization of fluids or salts in pores (e.g., freeze/thaw cycles).

Many materials science tools are available to elucidate these phenomena. Computational materials science, however, provides a particularly facile means for examining material response to a wide variety of physical conditions. A recently observed phenomenon in polycrystalline materials

with crystalline thermal expansion anisotropy is the development of residual-stress networks upon cooling or heating. Moreover, the length scale of these networks encompasses many grains. To study this and related phenomena, two- and three-dimensional model microstructures were generated with a pixel/voxel-based tesellation technique that constructs grains whose morphologies conform to a predefined statistical distribution. Crystal orientations were overlaid on the grain structure such that grain orientation and misorientation distribution functions also match predefined statistical distributions. Microstructure-based finite-element simulations wre then used to elucidate the origin of the residual stress networks, and to characterize the influence of texture on network size and associated polycrystalline physical properties, such as bulk thermal expansion and microcracking propensity.

June 22 ***Where the Action Is…***

Here we have the phone booth analogy, ***FIVE*** of the 2004 SURF students in Dr. Terrell Vanderah's (Materials Science and Engineering Laboratory) one single-bay prep lab.

June 23 NIST Safety Orientation for Summer Students – 2nd SURF Group Entrance

The session provided an overview, including how to report emergencies, use of personal protective equipment, general safety, office ergonomics, lab safety, and radiation safety.

June 25 Laurie Locascio
NIST Chemical Science and Technology Laboratory, Analytical Chemistry Division

Microfluidics: Performing Nanochemistry in Tiny Tubes

Liposomes have been used for many years in a variety of clinical and pharmaceutical applications related to drug encapsulation, targeting, and delivery. Liposomes are spherical structures composed of phospholipid bilayer membranes that self-assemble when lipid molecules are dispersed in aqueous solutions. Liposomes contain an aqueous core and, depending on the components that form the bilayer membrane, many reagents can be encapsulated stably inside liposomes including therapeutic agents, DNA, and proteins. For many years, we have used liposomes in ourlaboratories

as analytical reagents for signal amplification in immunoassays and DNA hybridization assays. Currently, we are exploring other analytical uses of liposomes focusing on their application in microfluidic systems as selective reagents for the performance of automated and targeted microchemical reactions. We have also recently been exploring methods for the automated formation of liposomes in microfluidic systems. In this presentation, we will discuss several aspects of our research related to liposomes in microfluidic systems including the formation of liposome vesicles in microfluidic systems under various conditions; encapsulation efficiencies of different reagents inside liposomes made in microfluidic systems; and their application as reagents for automated microfluidic chemical reaction.

July 1 Physics Laboratory SURF Students Presented at the 14th International Conference on Solid State Dosimetry at Yale University

Angel Fuentes-Figueroa and Angelica Perez-Andujar, both of the University of Puerto Rico at Mayagüez and SURF students in the Ionizing Radiation Division of the Physics Laboratory, were invited to give oral presentations at the 14th International Conference on Solid State Dosimetry, hosted by the Department of Therapeutic Radiology of Yale University. The SURFers were working with Dr. Leticia Pibida and presented a paper during the "Radiation Detection for Counter Terrorism" session. The papers are expected to be published in the Conference Proceedings in early 2005.

July 2 Isabel Beichl
NIST Information Technology Laboratory, Mathematical and Computational Sciences Division

Counting, the Monte Carlo Way

For more than 60 years, the Monte Carlo method has been used to approximate quantities that are very difficult or even impossible to compute by any other method. One classical example is the use of Monte Carlo to estimate complicated integrals.

In recent years, Monte Carlo methods have begun to be used for discrete counting problems, such as counting independent sets on graphs. At first glance, the use of Monte Carlo for counting seems strange. How can one get an exact answer for a discrete problem by an approximate, floating

point method? This feels much different from approximating an integral! But really it's not all that odd. We're trying to get an approximation, not an exact answer. And counting is really a kind of integration anyhow.

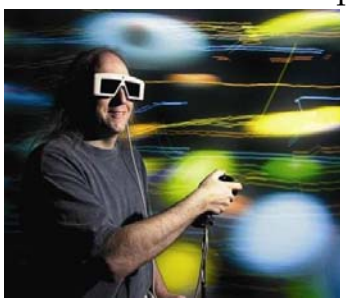
Some powerful Monte Carlo methods for counting were described and their use illustrated on some hard problems.

July 6 Steven Satterfield and SURFer Whitney Austin
Information Technology Laboratory, Scientific and Visualization Group

RAVE (Reconfigurable Automatic Virtual Reality Environment)

A number of SURFers got a demonstration of RAVE and to get the full affect everyone got a chance to be "immersed" in the environment.

The Scientific Applications and Visualization Group (SAVG) of ITL's Mathematical and Computational Sciences Division has developed an



immersive visualization environment that can be used to gain increased insight into large, complex data sets. Such data sets are becoming more commonplace at NIST, as high performance parallel computing is used to develop higher fidelity simulations, and combinatorial experimental techniques are used in the laboratory. Immersive visualization environments allow the scientist to interactively explore complex data by literally putting oneself inside the data.

July 9 Susan Ballou
NIST Electronics and Electrical Engineering Laboratory, Office of Law Enforcement Standards

CSI Exists at NIST

Most criminal investigations today will involve or be assisted by some device or tool of technology. In general, to ensure a thorough investigation, law enforcement and forensic scientists must not be overwhelmed by the technology. NIST has been requested to assist with this concern by providing simple and novel solutions. Some of these solutions are in the form of Standard Reference Materials (SRMs), Reference Materials (Rms) or research into new methodologies. The presentation provided a brief overview of some projects taking place at NIST that included a discussion on their need, their impact, and their

application to a high profile homicide case.

July 14 ***Budding Scientists Join NIST Team***

by Ashley Parker
Special to *The Gazette (Gaithersburg)*

College students (from left) Ramsey Zeitoun of Gaithersburg, Caitlin Baum of Gaithersburg, Stephanie Goldfarb of Bethesda and Kevin Wepasnick of Laytonsville are spending the summer as interns at the National Institute of Standards and Technology in Gaithersburg.

Ramsey Zeitoun, 20, was in over his head – exponentially. The kind of over-your-head that occurs with even the brightest chemical engineering majors at the University of Maryland, when you're suddenly thrown into the National Institute of Standards and Technology Summer Undergraduate Research Fellowship program, alongside hundreds of highly trained professional researcheers, scientists and engineers.

Zeitoun's project: Helping to construct a bimuth filter for neutron spectroscopy.

"I had no idea what was going on," said Zeitoun, a Gaithersburg resident who is entering his junior year at the University of Maryland next fall. "They just gave me a bunch of papers and they sat down and explained everything to me – more than once. Some of the stuff was way over my head, so it didn't stick the first time."

But now, well into his second summer in the NIST-SURF program in Gaithersburg, Zeitoun's project is becoming more manageable.

"The first year it took me a really long time to figure out what I was doing, but this year it's finally coming to me," he said.

Caitlin Baum, 18, a Gaithersburg resident and rising sophomore at University of Maryland – Baltimore County who joined SURF for the first time this year, said she is tackling a similar problem with the help of her mentor.

"Since I'm a freshman and I haven't had organic chemistry yet it's a little hard to understand all the details of it," Baum said, noting that her

biochemistry major hasn't much helped her engineering-based project, but she's improving by the day. "My menter is helping me, so I know enough to explain it to my friends and family."

But Baum and Zeitoun are quick studies – they're two of 104 college undergraduates in the SURF program, whittled down from a pool of roughly 360 applicants, and one elite group that electronics engineer and SURF Director Lisa Fronczek described as "the cream."

"Each year's group is becoming harder and harder for us to pick our 100 or so students," Fronczek said. "They come in excited and ready to work. I think this group is just the same."

There's also the support that the NIST staff provides, as each SURF member receives a NIST mentor carefully matched to the student's interest and field.

Zeitoun, for instance, is working in the materials science and engineering lab, while Van Molino, 21, a Gaithersburg resident and rising senior at Princeton University, who is returning to SURF for his second summer, is working in the information technology laboratory.

"Both years everybody in the division has been awesome, and they're always willing to shat what they're up to and their research with you," Molino said. "It's sort of intimidating at first, but they do a great job of maing you feel like you belong. They give you lots of respect and listen to your ideas. I sort of feel like I'm a member of the division for the summer."

And he might as well be – this summer he's helping to develop a course that will be taught to other NIST scientists, and he will be teaching part of te course come August, and last summer he found himself mathematically modeling the fusion of aerosol particles.

Moline said his two NIST summers have prepared him for the two disciplines he hopes to pursue upon graduation – research and teaching.

"I'm very glad I got to do both of them, because I'm very interested in a career in academia," he said. "One summer gave me a flavor for research and the other summer gave me a flavor for teaching."

Molino appreciated the time he spent sitting on on consulting meetings, absorbing the knowledge of experts.

"I saw they were doing some really cool, cutting edge stuff at NIST, stuff that's just very pertinent to modern events and what's going on in the world," he said. I thought it was very cool that you can do research on these very cutting edge areas like homeland security and terrorism. It's not all ivory tower mathematics."

And this, Fronczek said, is exactly the goal of SURF. In addition, to giving the young protegees an opportunity to gain some hands on experience, SURF aims to promote science and engineering as a career choice.

"In general, science and engineering is not the first choice for a lot of students," Fronczek said. "It's probably harder for students to see the payoff, and plus it takes a lot of discipline, so we're trying to give students a chance."

SURF, now in its 15th year, offers a series of guest speakers called SURF Seminars, which may pique students' interest in any number of scientific fields.

Laytonsville resident, Kevin Wepasnick, 20, a rising junior at Franklin & Marshall College outside of Lancaster, Pa., said he especially likes the lectures and the new understanding and insight they bring.

"The seminars that they have are very informative and interesting, and they've added new depth to what I'm learning about, so it's pretty exciting," he said. "There was definitely a noticeable change in attitude because at school people don't really seem to care about what's going on, but here everyone is very focused. It's nice to hear people asking good questions about the lectures and getting good answers."

SURF culminates with a three-day colloquium, designed to give participants an opportunity to share their respective projects, which include everything from nuclear research to robotics to burn testing.

"The students stand up and give a presentation of their work to their fellow students, a NIST audience, and VIPS from the National Science Foundation," Fronczek said. "So the students get a hint of what it's like to go to a professional conference and give a talk."

Zeitoun, for his part, said he got a taste of neutron spectroscopy last summer, and this summer came back to finish his project.

"I kinda felt bad just leaving it undone," he said, on his decision to return to N IST for round two. "It's a continuation of the same project. I came back and didn't lose much time."

Besides, there's just something exciting about "being able to be around a nuclear reactor in Gaithersburg that you didn't evenknow about," Zeitoun said.

Although Baum, Molino, Wepasnick and Zeitoun all hail from Montgomery County, the program attracts students from all across the United States, and Puerto Rico.

For th is reason, Bethesda resident and rising Cornell sophomore Stephanie Goldfarb, 19, said she was one of two locals who chose to have the full NIST experience and room with other SURF students in housing provided by the program. In addition to housing, NIST provides all SURF participants with a $4,000 stipend and travel fees.

"One of my roommates is from Puerto Rico, one is from Chicago, and one is from Virginia," Goldfarb said. "I've really enjoyed the experience of being in the apartment. It's been a good medium between being at home and being on my own."

Baum, who lives at home, said she has found another way to stay connected with the SURF group – ultimate Frisbee games, twice a week, at the NIST fields. "It's kind of stress relief," she said.

July 16 Rebecca Ghent
Smithsonian Institution, Center for Earth Planetary Studies (former SURF student)

In Search of Water on Mars: The Findings of Spirit and Opportunity

The twin Mars Exploration Rovers (MER) currently exploring the surface of Mars represents an unpredecented opportunity to understand the geological histories of two very different locales.

Mars may have experienced a period in the distant past which liquid water flowed on the surface. The MER rovers, Spirit and Opportunity, have been exploring two sites that may have held liquid water since early in 2004. Because water is a required ingredient for the evolution and persistance of life as we know it, the idea that lakes or oceans may have existed on Mars inevitably introduces the tantalizing prospect of fromer or

current life on the red planet. In part for this reason, NASA's Mars exploration mission focuses on understanding the current and past distribution, forms, and history of water, and the MER rovers are pursuing that goal. Both rovers performed at a level exceeding their nominal missions and are now fulfilling their extended missions. In the talk, Dr. Gent looked at the scientific results from both rovers and explored their implications for the past presence of water at two sites on Mars.

July 21 Summer Horizons Program, University of Maryland Baltimore County

UMBC Graduate School invited any and all SURFers to attend the annual Summer Horizons program to take a day to introduce the students to graduate opportunities…not just the UMBC graduate school, but graduate school in general. Speakers were invited to discuss the GRE (with examples from the exam, authorized by the Educational Testing Service), how graduate school admissions processes work, and fellowships. The program also included lab tours. Students from other summer research programs at UMBC, University of Maryland College Park, NASA, NISH, and NSF.

July 23 Alan Lytle
NIST Building and Fire Research Laboratory, Materials and Construction Research Division

An Introduction to LADAR Systems

Ground-based laser radar (LADAR) systems are providing the construction industry with new tools and methods for capturing existing site conditions and model civil infrastructure. The NIST Construction Metrology and Automation Group (CMAG) has ongoing research examining the use of LADAR systems in construction applications ranging from terrain characterization, earthmoving analysis, object identification, and autonomous control of construction vehicles. The presentation introduced the basic operation of LADAR systems and reviewed some of the research efforts.

July 27 Pentagon Tour

The SURFers had the great opportunity of touring The Pentagon. The tour route was approximately 1 1/2 miles in length and lasted for about 90 minutes. The tour

covered about 20 items of interest that included the mission of the Department of Defense and each of its branches of services, and numerous displays that highlighted and depicted significant moments in military history.

July 30 Mr. Donald Swenholt
Donald Swenholt Associates, Inc.

Giving Successful Presentations

Mr. Swenholt presented a few techniques and up-to-date procedures to assist the students in presenting their talks for the end-of-the-program SURF student symposium.

August 3 Tour of the NIST Center for Neutron Research

Students visited three science stations that use neutron beam lines for their experiments.

August 10 Final Presentations by SURF Students moderated by invited guests

August 10 Lunch with special invited guests

August 11 Final Presentations by SURF students moderated by invited guests

August 12 Final Presentations by SURF students moderated by invited guests

August 13 Last Day for SURF students